To: Staci Goodwin, TMDL Program Manager, IDEM
From: Rhett Moore, Senior Hydrologist, WHPA Inc.
Date: October 31, 2003
Subject: Salt Creek Loading Allocation Report

TECHNICAL MEMORANDUM

This memorandum describes WHPA's efforts in developing load allocations and an implementation strategy for the Salt Creek *E. coli* TMDL. In previous work, the source inputs of *E. coli* in the watershed were characterized [WHPA, 2003d]. Both point and nonpoint sources are present in the watershed. Linkage of the combined impact of the various sources was accomplished with a comprehensive watershed/water-quality model. Documentation of the development, calibration, and verification of the HSPF model was included in a previous memorandums [WHPA, 2003b, WHPA, 2003c]. Through calibration of model parameters and representation of watershed sources, the in-stream response was linked to source inputs and environmental conditions. The calibrated model was then applied to formulate potential *E. coli* allocations.

The following will be discussed:

1. Critical Conditions
2. Total Maximum Daily Load Analysis
3. Implementation
4. References

1 Critical Conditions

The goal of the TMDL program is to reduce the *E. coli* concentrations in Salt Creek to a level that meets its designated-use standard for a full body contact recreational stream. Indiana's water-quality standard for recreational waters is set forth in 327 I.A.C. 2-1-6 and 2-1.5-8(e)(2) [IDEM, 2002]. The standard reads "*E. coli* bacteria, using membrane filter (MF) shall not exceed one hundred twenty five (125) per one hundred (100) milliliters as a geometric mean based on no less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period."

Previous work has demonstrated that there is no single critical condition associated with violations of the dual *E. coli* standard in Salt Creek. Load-duration curve analysis revealed that exceedances of the single-sample standard occur throughout the flow regime. A higher percentage of exceedances were observed, however, in the high to middle range of flows (2-60 percent flow duration), indicating that concentrations above the standard are likely associated with nonpoint sources or other precipitation-driven inputs such as storm sewer discharges and CSOs [WHPA, 2003a]. Additional analyses in the Salt Creek Data Report confirmed that exceedances in the creek and its tributaries were associated with precipitation events. The modeling analysis also confirmed the importance of precipitation events in contributing to elevated concentrations in the creek [WHPA, 2003b]. The HSPF model of the watershed employed for this analysis was calibrated over an entire recreational season. The calibration period provided a good opportunity for evaluating a range of conditions in the watershed and allowed proper consideration of the the critical conditions of impairment.

2 Total Maximum Daily Load Analysis

A TMDL represents the maximum capacity of a waterbody to assimilate a pollutant while safely meeting the respective water-quality standard. The TMDL for a given waterbody and pollutant is the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels [U.S. EPA, 2001]. The sum of the allocations must not result in the exceedance of the water-quality standard. In addition, a margin of safety (MOS) must be included in the analysis, either implicitly or explicitly. The MOS accounts for any uncertainty in the relationship between loads and conditions in the receiving water and helps to ensure that the water-quality standard is met. These concepts can be expressed conceptually by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

Developing allocations for point and nonpoint sources presents a challenge for bacteria TMDLs. TMDLs are traditionally expressed in terms of loads (mass per unit time). However, mass is not an appropriate unit for pathogens. Concentrations of indicators such as *E. coli* are usually reported in units of “colony forming units per unit volume” or “counts per unit volume.” In addition, the dynamic nature of bacteria loading and the range of critical conditions presented by such diffuse sources makes assignment of fixed loads insufficient for the quantification required by a TMDL. Federal regulations allow TMDLs to be expressed in “other appropriate measures” [40 CFR 130.2 (i)]. It is common for bacteria TMDLs to be expressed as a concentration or as a percent reduction required for attainment of the standard. This TMDL is expressed as a total percent reduction based on a statistical measure of the existing and target conditions. The WLA and LA are expressed as portions of the total reduction, the sum of which equals the reduction necessary to achieve the loading capacity of Salt Creek. An explicit MOS is included in the TMDL.

2.1 Development of Target Conditions and MOS

The total percent reduction that forms the TMDL and the respective allocations were calculated by statistical methods. The method employed is modeled after concepts presented as Statistical Rollback Theory by Ott [1995]. However, the analysis presented here does not assume geometric scaling of the post-control distribution. Probability distributions of *E. coli* concentrations predicted by the watershed model were analyzed to assess the linkage of sources with in-stream effects and set the TMDL values. A probability distribution is an excellent way to examine properties of a water-quality sample set. Graphical analysis of the distribution allows convenient comparison of predicted concentrations with both the single-sample and geometric-mean standard. The 100^{th}percentile of the data set represents the maximum concentration and allows direct comparison with the single-sample standard. The geometric mean of the data set is given by the 50^{th}percentile and allows comparison with the geometric mean standard.

Figure 1 shows the results of the statistical analysis. Existing conditions were defined as the distribution of concentrations predicted by the calibrated model [WHPA, 2003b, WHPA, 2003c]. The distribution includes the predicted *E. coli* concentration for each day of the calibration period (the 1998 recreational season). By using the distribution of the entire recreational season, the range of conditions that represent the critical conditions is incorporated into the TMDL. The predicted distribution was approximated as lognormal. Distributions of water-quality data are commonly lognormal. The lognormal regression is included on the graph with the resulting correlation coefficient. The regression model predicts a 100^{th}percentile value of 1445 $CFU/100\,ml$.

The TMDL was calculated by determining the total percent reduction required to reduce the 100^{th}percentile of the distribution from existing conditions to the target conditions. The loading capacity was defined as a distribution with a 100^{th} percentile value equal to the single-sample standard of 235 $CFU/100\,ml$. The TMDL must incorporate a MOS that accounts for uncertainty in the analysis linking pollutant loads and conditions in the creek. The MOS was incorporated by defining target conditions as a distribution with a 100^{th} percentile equal to 170 $CFU/100\,ml$. The TMDL was calculated as the percent reduction required such that the 100^{th} percentile of the distribution representing existing conditions is equal to that representing the target conditions. The total reduction required is 88%. The MOS portion of the total reduction is 4%. The MOS portion of the TMDL is relatively low compared to the LA and the WLA. However, the MOS was determined with a 100^{th} percentile value that is 28% lower than the single-sample standard and is considered appropriate given the robust modeling analysis used for linking sources and conditions in the creek.

2.2 Assignment of WLA and LA

The WLA and LA were calculated as portions of the total reduction required to achieve the target conditions defined above. Ten NPDES facilities in the watershed are sources of *E. coli* [WHPA, 2003d]. All ten

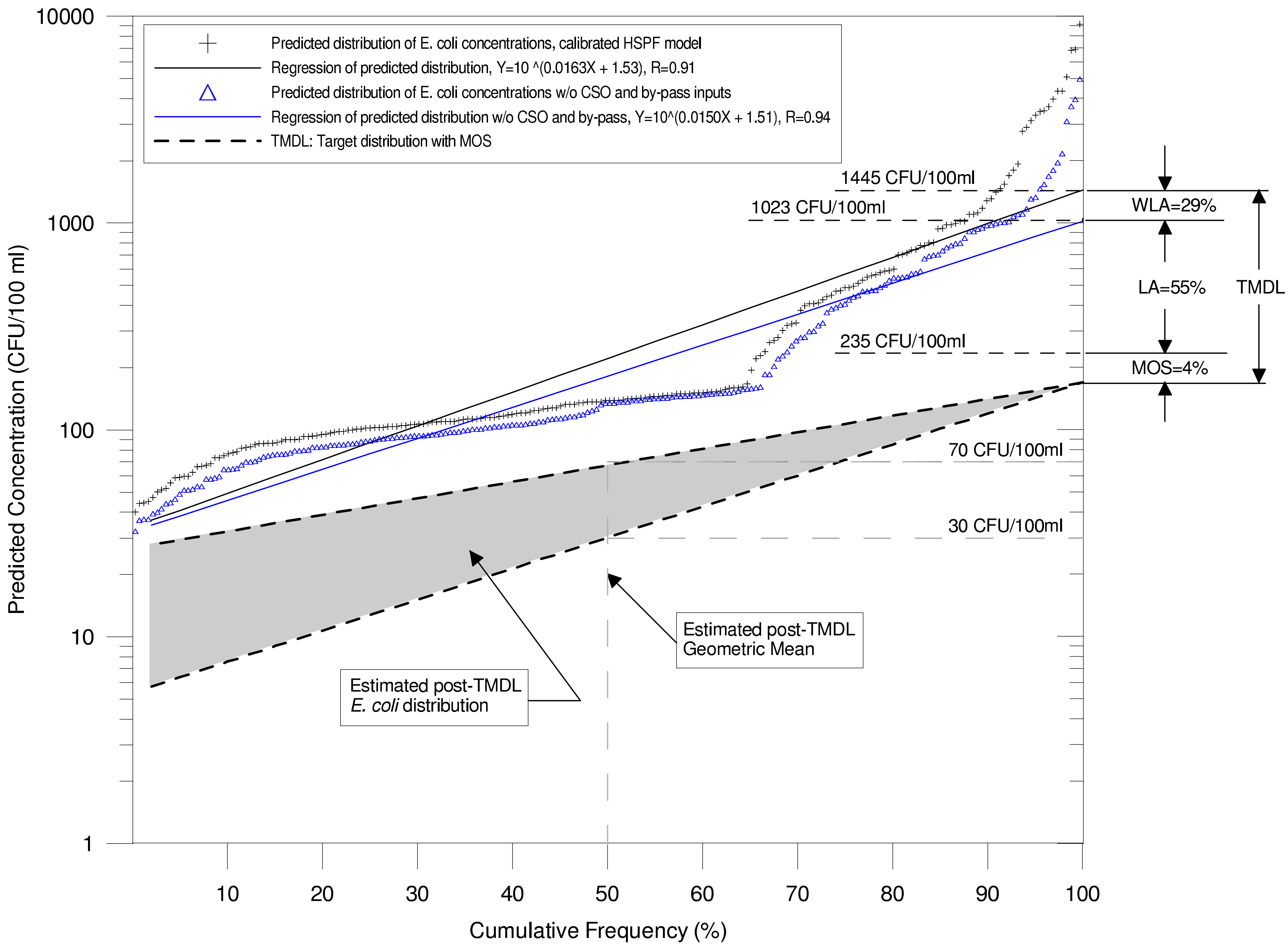

Figure 1: Graphical representation of the statistical method used to calculate the E. coli TMDL target and allocations for Salt Creek.

permittees are required to treat the waste stream and to monitor for *E. coli*, fecal coliform, or residual chlorine. Some are required to monitor for a combination of the three parameters. All of the permits are issued with the purpose of meeting the water-quality standard for *E. coli* in the receiving water. It was assumed that those permittees required only to monitor for residual chlorine were meeting the single-sample standard if the permitted residual levels were met. All facilities required to monitor for only residual chlorine will be required by IDEM during the next permit cycle to monitor for *E. coli*.

Load estimates based on 1998 data from Discharge Monitoring Reports showed that inputs due to the CSO at Valparaiso and bypasses from several of the facilities were significantly higher than the combined ambient inputs [WHPA, 2003d]. Bypasses are defined as "the intentional diversion of waste streams from any portion of an Industrial User's treatment facility" [40 CFR122.41(m)(l)]. Section 402 of the Clean Water Act prohibits bypasses from wastewater treatment facilities unless the bypass does not violate the permit or other specific extenuating circumstances are present. Indiana has in place a CSO Control Strategy to bring the State into compliance with the requirements of the Clean Water Act. The city of Valparaiso's Long Term Control Plan (LTCP) for the CSO was submitted to the State earlier in 2003 and is currently under review. The LTCP will help the city in meeting the water-quality standard for *E. coli*.

The WLA was calculated as the percent reduction achievable by eliminating all bypass flows and reducing the CSO input concentrations to the geometric mean standard of $125\,CFU/100\,ml$. The geometric mean standard was used to calculate the percent reduction achievable by the point source controls described above, the model inputs were adjusted accordingly, and the resulting distribution of predicted concentrations was fitted to a lognormal model (Figure 1) in the same way as described above for the existing conditions. The model predicts how the distribution of concentrations will change in the post-control state. The post-control distribution is lower, as expected, and tilted more toward the right. The tilt is represented by the lognormal model as a decrease in the slope of the regression line. The tilt is due to the reduction of CSO inputs in the model. CSO inputs are sporadic, but cause very high daily concentrations. Reducing CSO inputs in the model reduces values in the upper end of the distribution, causing the regression line to decrease and tilt more toward the right. The lognormal model of the post-control results predicts a distribution with a 100^{th} percentile concentration of $1023\,CFU/100\,ml$. The resulting reduction represents the WLA of the TMDL. Of the total 88% reduction required to meet the target conditions, 29% is the WLA. The 29% reduction represents the WLA portion of the TMDL. The remaining reduction required to meet the target conditions, 55%, is assigned to the LA. The TMDL elements are summarized in Table 1.

The predicted post-TMDL distribution of concentrations is shown in Figure 1. The 100^{th} percentile of the distribution was defined as necessary for achievement of the TMDL (described above). The slope of the regression was estimated as having a range. The slope was bracketed between the slope of the post-control distribution (upper bound) and the slope of the modeled distributions in the middle frequencies (30%-70% cumulative frequency). Reducing nonpoint source inputs will reduce the slope of the distribution

Table 1: Salt Creek TMDL components.

Pollutant	WLA	LA	MOS	TMDL[1]
E. coli	29%	55%	4%	88%

[1]Expressed as reduction required to reduce the 100thpercentile of the E. coli distribution to the single-sample standard, with MOS

similar to the change in slope seen by reducing CSO inputs. Like the CSO, diffuse sources are episodic, but contribute high daily concentrations. It is assumed that reducing nonpoint source inputs will not decrease the slope of the distribution more than the slope represented by the middle range of concentrations since these concentrations should be unaffected by nonpoint source controls.

The geometric mean of the lognormal distribution is estimated by the 50$^{\text{th}}$percentile. While this value represents the geometric mean of the distribution of concentrations over the entire recreational season and the geometric water-quality standard applies only to a subset of the samples over any 30-day period, it is useful to compare the predicted geometric mean with the geometric standard. Given the assumptions to estimate the slope of the distribution, the geometric mean of the post-TMDL distribution was estimated to be between 30 and 70 $CFU/100\,ml$, values well below the geometric mean standard of 125 $CFU/100\,ml$.

3 Implementation Activities and Schedule

3.1 Implementation Actions

Reduction of *E. coli* concentrations in Salt Creek must be actively pursued. Implementation actions for point source and nonpoint source reduction are provided, as well as, descriptions of current programs that will help reduce *E. coli* loads to Salt Creek.

3.1.1 Point Source Actions

NPDES permits Only five of the ten NPDES facilities within the watershed that discharge *E. coli* are required to monitor *E. coli* levels in their effluent. The five that are not required to monitor *E. coli* monitor either residual chlorine and/or fecal coliform. *E. coli* measurements from all facilities would help inform the TMDL implementation process. During the next permit renewal, *E. coli* limits and *E. coli* monitoring will be added to the permit requirements for all ten facilities.

CSO Long Term Control Plan In 1994, the USEPA published the National Combined Sewer Overflow (CSO) Control Policy. In accordance with that policy, IDEM amended Indiana's CSO Strategy to bring

Indiana into compliance with the requirements of the Clean Water Act. Phase I of the National CSO Policy requires that “nine minimum controls” be implemented. These controls are 1) proper operational and regular maintenance 2) maximum use of the collection system for storage 3) review and modification of pretreatment programs 4) maximization of flow to the treatment plant 5) prohibition of CSO discharges during dry weather 6) control of solid and floatable materials in CSO discharges 7) pollution prevention programs 8) public notification of CSO occurrences and impacts, and 9) monitoring to effectively characterize CSO impacts. In addition, the city must characterize the stream reach and submit a Long Term Control Plan (LTCP) for approval by IDEM.

The city of Valparaiso has the only combined sewer system in the Salt Creek watershed. In accordance with Indiana’s CSO Strategy, Valparaiso submitted its LTCP in 2003. It is currently under review by IDEM. However, improvements at the Elden Kuehl Pollution Control Facility, the city’s wastewater treatment plant, have already begun with the “Upgrade and Expansion Project.” The improvements include modifications to the existing CSO tanks, expansion of the headworks facility, conversion of two-stage nitrification system to a single stage nitrification, installation of two new circular clarifiers, replacement of tertiary filter media, a new laboratory building, and other miscellaneous improvements. In addition, since October 2001 the city submits monthly Discharge Monitoring Reports (DMR) to record the occurrence of overflows. The improvements to the wastewater treatment plant and the future advancements planned in the LTCP will assist Valparaiso in meeting the water-quality standard for *E. coli*.

Bypasses Bypasses are defined as “the intentional diversion of waste streams from any portion of an Industrial User’s treatment facility [40 CFR122.41(m)(l)].” Section 402 of the Clean Water Act prohibits "bypasses" from wastewater treatment facilities unless: (a) it was unavoidable to prevent loss of life, personal injury, or severe property damage (b) there was no feasible alternative to bypass (c) the industrial user submitted notices as required under Federal, State, or local regulations (d) it does not result in any condition which violates the users permit. The typical NPDES limit for *E. coli* is an average concentration of 125 $CFU/100\,ml$ and a maximum concentration of 235 $CFU/100\,ml$.

Of the bypass exceptions, (b) requiring “no feasible alternative” has been challenged most often. However, in a recent federal case, *United States v. City of Toledo, Ohio*, the Federal Court ruled that “any bypass which occurs because of inadequate plant capacity is unauthorized...to the extent that there are ’feasible alternatives,’ including construction or installation of additional treatment capacity [USEPA, 2000].” The ruling emphasizes the importance of communities assessing whether each treatment facility has adequate storage and/or treatment capacity.

The occurrences of bypasses in the Salt Creek watershed has been reduced in recent years. In 2002, only one facility, South Haven Sewer Works, had bypass discharges into the creek. Ensuring sufficient facility capacity will continue to reduce the occurrence of bypasses in Salt Creek.

3.1.2 Nonpoint Source Actions

Nonpoint-source pollution can be reduced by the implementation of "best management practices" (BMPs). BMPs are structural and management practices which are used in agriculture, forestry, urban land development, and industry to reduce the potential for damage to natural resources from human activities [IDEM, 2002]. A BMP may be structural, something that is built or involves changes in landforms or equipment, or it may be managerial, a specific way of using or handling infrastructure or resources. BMPs can be implemented by livestock owners, farmers, and urban planners. For reduction of *E. coli* runoff, the following are recommended:

Riparian Area Management Riparian zones are the areas along the sides of streams. Beneficial management involves allowing buffer zones of vegetation to grow, either grasses, legumes, or trees. Riparian area buffer zones can trap coliform bacteria, soluble nutrients, and soluble pesticides in runoff water. These areas can also reduce water erosion and provide food and nesting cover for wildlife. The effectiveness of riparian buffer zones is increased as the width of the zone is increased. Management of riparian areas is beneficial for streams near urban developments, cropland, and pastureland.

Contour Row Crops Contour agriculture is farming with row patterns aligned at or nearly perpendicular to the slope of the land. This type of farming reduces erosion, controls water runoff, and improves water quality. Excess runoff from contours is often directed to field borders, vegetative filter strips, or grassed waterways.

No-Till Farming No-till is a year-round conservation farming system. In its pure form, no-till does not include any tillage operations either before or after planting. The practice reduces water erosion, protects water quality, and provides wildlife habitat.

Manure Collection and Storage Manure from livestock is often applied to cropland and pastureland as fertilizer. While providing beneficial nutrients, this practice, unfortunately, can contribute to the bacteria load of streams. Collecting and storing manure so that it does not runoff can reduce bacteria concentrations in streams. Manure should be collected each day and stored.

Manure Nutrient-Testing If manure application is desired, sampling and chemical analysis of manure should be performed to determine nutrient content for establishing the proper manure application rate. Knowing the nutrient content of manure will help reduce the possibility of over application and minimize nutrient and bacteria runoff. Nutrient content of manure varies widely with animal type, age, and size; feed;

manure storage system; and climate. For these reasons, determination of manure nutrient values from sampling and laboratory analysis is preferable to using average values. Manure should be re-sampled if changes in management, handling, or feeding occur.

Soil Nutrient-Testing Soil testing evaluates the amount of nitrogen and phosphorus in the soil available for crops. Fertilizer recommendations that match crop needs can help landowners apply appropriate amounts of fertilizer. Soils should be sampled one to six months prior to fertilizer application. The results should be analyzed by a professional agronomist to make fertilizer recommendations. All homeowners, businesses, and farmers are encouraged to have their soil tested for nutrient content.

Drift Fences Drift fences (short fences or barriers) can be installed to direct livestock movement. The fences manipulate livestock patterns in a way that reduces soil erosion problems and keeps livestock away from surface waters. A drift fence parallel to a stream keep animals out and prevents direct input of *E. coli* to the stream.

Pet Clean-up / Education Education programs for pet owners can improve water quality of runoff from urban areas. Teaching citizens to pick up and dispose of their pet's feces can reduce the amount of *E. coli* entering the streams through stormwater.

3.1.3 Water Protection Projects

Phase II Stormwater Project The EPA Phase II Stormwater Project is the part of the nonpoint source pollution regulation under the Clean Water Act. The stormwater rule, effective October 29, 1999, requires communities with populations under 100,000 to meet permit program conditions aimed at controlling water pollution caused by stormwater runoff [USEPA, 2003b]. The rule requires communities to implement a municipal stormwater management program that includes a list of six minimum stormwater control measures.

Indiana's Rule 13 meets the guidelines set by the EPA's Phase II stormwater regulations. The City of Valparaiso has already begun implementing some of the six minimum control measures required by Rule 13:

1. Public Education and Outreach - information regarding Phase II is on the city website.
2. Illicit Discharge Detection and Elimination - the city is photographing and mapping all outfalls from the stormwater system.
3. Construction Site Stormwater Runoff Control - the city currently requires erosion control measures at construction sites.

Perimeter Drain Locations A septic-field perimeter drain is used to drain wet soils due to a high water table. Perimeter drains usually discharge to field tiles, open ditches, or to the ground surface on the side of a slope. Drainage of soils in such close proximity of septic systems has the potential to discharge *E. coli* contaminated water into surface waters. Location, identification, assessment, and possible remediation of perimeter drains in the Salt Creek watershed may help reduce the *E. coli* load to the stream. A stakeholder from the Salt Creek Source Assessment Stakeholder Meeting held on June 25, 2003 expressed concern about the potential negative impacts of perimeter drains in the Damon Run watershed.

List of Projects Conditionally Selected for Funding Additional projects in the Salt Creek watershed that may enhance the water quality of the stream are being funded through the Great Lakes Coastal Restoration Grants Program. The Indiana Great Lakes Coastal Restoration Grants Program is a new grants program established in 2001 as a means to distribute Indiana's portion of a Congressional award to Great Lakes states. Indiana's funds will be used to restore and protect rivers, streams, lakes, wetlands, and habitat for endangered wildlife in Indiana's Lake Michigan coastal region [IDNR, 2003]. Five of the projects selected for funding will benefit the Salt Creek watershed. All have been conditionally selected and are currently waiting for federal approval. A description of these projects is provided below [IDNR, 2003].

- *Restore and Enhance Samuelson's Fen and Salt Creek at Imagination Glen Park.* This project will restore and enhance the natural communities associated with Salt Creek, which bisects the 250-acre Imagination Glen Park.

- *Phase 2b: Creekside Park Development.* This project will develop trails and an environmental management plan for a 70-acre undeveloped park. The project will also restore and maintain native upland habitat, wetlands, fens, and Salt Creek corridor (a salmonid stream).

- *Phase 2c: Creekside Park Development.* This project will assist in the development of boardwalks and a bridge crossing for public access and restore 10-40 acres with native vegetation to Creekside Park, a 70-acre undeveloped park.

- *Stimson Drain Stormwater Best Management Practices Management Design Project.* This project will produce a stormwater management design that will promote various best management practices for the 600-acre Stimson Drain Watershed.

- *Porter County Jail Alternative Stormwater Management Demonstration Project.* The newly constructed Porter County Jail is located in the Stimson Drain Watershed, which is undergoing significant commercial development. This on-site demonstration project will reduce and manage the impact of stormwater in the watershed.

3.2 Schedule for Implementation

Implementation activities the first year after TMDL approval will consist of continuing the monitoring program. Also during the first year, funding opportunities for BMP implementation should be pursued. Nonpoint-source pollution funding opportunities are listed on the USEPA website [2003]. The second and third years should see continued monitoring and the implementation of BMPs. During the fourth and fifth year, the effectiveness of TMDL implementation practices will be analyzed using the monitoring data. Management programs, BMPs, monitoring and evaluation of data, and periodic status reports must continue throughout the implementation plan. If *E. coli* concentrations in Salt Creek remain above the standard ($235 CFU/100 ml$) during the implementation, then a more stringent plan must be adopted.

3.3 Reasonable Assurance

Reasonable assurance of implementation plan success is supplied by water-quality monitoring and ongoing programs occurring in the watershed. Programs such as the CSO Long Term Control Plan and the Stormwater Program help insure that CSOs and stormwater will have a reduced impact in the watershed. Monitoring also assures the effectiveness of the implementation plan. The water quality in Salt Creek will continue to be monitored throughout the implementation plan. The following organizations / projects are responsible for the water-quality monitoring:

- IDEM fixed station data collection
- IDEM Surface Water Monitoring Program - Five-year rotating basins approach
- Discharge Monitoring Reports from NPDES Facilities

The data collected will be used to show progress towards *E. coli* concentration reduction in the stream. If progress is not shown, changes in the implementation plan will be made.

3.4 Legal or Regulatory Controls

The implementation of the TMDL will be facilitated / controlled by Indiana Department of Environmental Management (IDEM) officials.

3.5 Timeframe for Attainment of WQS

The projected attainment date is five years from the acceptance of this implementation plan by EPA. A five-year evaluation will determine the appropriateness and success of this implementation plan. If a reduction in the *E. coli* concentration is not shown, the implementation plan and/or the TMDL must be altered.

References

[IDEM, 2002] IDEM (2002). Downloaded from the Total Maximum Daily Load Program website. `http://www.in.gov/idem/water/planbr/wqs/303d.html`. Accessed on September 27, 2002.

[IDNR, 2003] IDNR (2003). Great Lakes Coastal Restoration Grants Program. `http://www.in.gov/dnr/lakemich/grants/glcrginfo.html`. Indiana Lake Michigan Coastal Program, Indiana Department of Natural Resources, Accessed October 27, 2003.

[Ott, 1995] Ott, W. (1995). *Environmental Statistics and Data Analysis*. Lewis Publishers, first edition.

[U.S. EPA, 2001] U.S. EPA (2001). Protocol for Developing Pathogen TMDLs. Office of Water, Washington, DC EPA/841-R-00-002, U.S. Environmental Protection Agency.

[USEPA, 2000] USEPA (2000). Clean Water Act Prohibits Sewage 'Bypasses'. Technical Report EPA 300-N-00-005, U.S. Environmental Protection Agency. Office of Regulatory Enforcement and Compliance Assurance, Enforcement Alert, Volume 3, Number 4.

[USEPA, 2003a] USEPA (2003a). Funding Opportunities for Nonpoint Source Pollution. `http://www.epa.gov/owow/nps/funding.html`. U.S. Environmental Protection Agency, Accessed October 27, 2003.

[USEPA, 2003b] USEPA (2003b). Storm Water Phase II Final Rule Fact Sheet Series. `http://cfpub.epa.gov/npdes/stormwater/swfinal.cfm`. U.S. Environmental Protection Agency, Accessed October 27, 2003.

[WHPA, 2003a] WHPA (2003a). Salt Creek *E. coli* TMDL Data Report. Technical Report, Wittman Hydro Planning Associates.

[WHPA, 2003b] WHPA (2003b). Salt Creek *E. coli* TMDL Modeling Analysis. Technical Memorandum, Wittman Hydro Planning Associates.

[WHPA, 2003c] WHPA (2003c). Salt Creek *E. coli* TMDL Modeling Framework. Technical Memorandum, Wittman Hydro Planning Associates.

[WHPA, 2003d] WHPA (2003d). Salt Creek *E. coli* TMDL Source Identification and Assessment Report. Technical Report, Wittman Hydro Planning Associates.